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Hydrology ▪ Hydraulics ▪ Engineering

9957 171 AVENUE SE
RENTON, WA 98059
(425) 271-5734

April 7, 2015

Mr. Bob Witkowski, Director
City of Ellensburg
Department of Community Development
501 North Anderson Street
Ellensburg, WA 98926

Re: Surf City Development – Flood Study

Dear Mr. Witkowski:

This report documents the methods and results of a flood hazard assessment I conducted for proposed developed on the Surf City property. The subject property is a commercial development located on Lakeside Way west of Canyon Road and north of Interstate 90, within the Wilson Creek watershed. The site mapped by FEMA as a Zone A1 flood area with flooding depths having been determined by FEMA.

I coordinated efforts with Encompass Engineering in conducting the following:

- Obtaining topographic survey data for the site
- Developing a hydraulic model to map the floodplain on the site, and
- Developing flood mitigation measures that are consistent with the city's current code. In addition, Encompass Engineering and I met with Brent Renfrow from Washington Department of Fish and Wildlife to develop flood mitigation measures designed to enhance the riparian corridor.

Current Site Flooding Conditions

The project site is located within a Zone A1 flood area as published on FEMA's FIRM. The project site is located within a reach of the Right Channel of Wilson Creek. Overflow from Wilson Creek leaves the creek's left bank during larger storms. Flood water leaving Wilson Creek flows inundates a significant portion of the project site with a predicted average depth of 1 foot for the 100-year flood flow. Wilson Creek flows through a bridge under Interstate 90 immediately downstream from the site thereby constricting the floodplain (Figure 1). As a result, much of the floodplain in the left overbank has flood storage but no conveyance. The parcel on the right bank of Wilson Creek is a lake, owned

by Washington Department of Fish and Wildlife. The lake is separated from the channel along with a berm that is generally above the base flood elevation in the lower reach of the study area.

The Surf City site was observed to have shallow flooding during the January 2009 flood. Based on oblique aerial photos of the January 2009 flood, the areal extent of flood generally matched the pattern as mapped by FEMA, but perhaps with a lesser extent of flooding, particularly in the southern portion of the site.

Modeling Approach

Both the existing site configuration and proposed site improvements were modeled using HEC-RAS hydraulic software assuming steady-state conditions (Version 4.1.0). My objective was to create a hydraulic model of the site that reproduced the base flood elevations on the site within a tolerance of 0.5 foot, otherwise known as a duplicate effective model. This model was then used as a basis to verify that the mitigated project resulted in zero-rise for the 100-year flood flow.

I submitted a public information request to FEMA Engineering Library to acquire documentation for the hydraulic model used to develop the floodplain map and base flood elevations published on the effective FIRM for the Right Channel of Wilson Creek. An electronic version of the hydraulic model used for Wilson Creek was not available (Adams, 2014). The U.S. Geological Survey performed the flood study in 1978 using the USGS Step-Backwater Program Version 77.18. FEMA Engineering Library did provide scanned copies of computer output from the 1978 flood study modeling results. These results were correlated to the published FEMA flood profiles for the Right Channel of Wilson Creek. From these results, flow rates for the reach through the project site used in the FIS were 349, 497, 561, and 710 cubic feet per second for the 10-year, 50-year, 100-year and 500-year storms.

Given the 35-year age of the prior study, new geometry data for the channel and floodplain were collected in the field to characterize existing site conditions (Figure 2). A total of 11 cross sections were surveyed to characterize the geometry of the channel and topography of the floodplain in the project reach. Cross sections covered the channel reach from just downstream of the I-90 crossing (Section K) to upstream of an existing bridge and irrigation diversion structure (Section A).

For proposed conditions, the geometry of the site was based on a grading plan for the proposed Surf City development (Encompass Engineering, April 2, 2015). The hydraulic

simulation for proposed developed conditions therefore includes the effects of proposed fill in the floodplain as well as compensatory storage volumes to mitigate for the fill.

The hydraulics of the floodplain in the left overbank is affected by the channel constriction at the I-90 crossing. The outer portion of the flood fringe provides flood storage but not conveyance and was modeled as an area of ineffective flow in the HEC-RS cross sections. The project site is between FEMA Cross Sections M and Q of the Right Channel of Wilson Creek (Appendix A). For the zero rise analysis conducted for the project site, flow rates obtained from the USGS Step-Backwater Program Version were used. These flow rates resulted in acceptable calibration of the model to the published FEMA base flood elevations. The downstream boundary condition for FEMA flood flow rates were set to elevations corresponding to the published FIS elevation for Cross Section BC of the Yakima River (Appendix A).

Staff at WDFW identified the ordinary high water (OHW) level for the channel along the project reach and these elevations were subsequently surveyed and used in the flood storage mitigation design. The flow rate corresponding to the creek's OHW level was determined using HEC-RAS with a trial-and-error approach to match predicted channel backwater elevations with those identified by WDFW staff in the field.

Modeling Results

The HEC-RAS model developed for the project reach predicts base flood elevations within 0.5 tolerance to those published in the FIS for existing site conditions. Based flood elevations for the site from the FIS and the HEC-RAS model results are provided in Table 1. The HEC-RAS predictions are within a 0.5 foot tolerance that FEMA requires in developing duplicate effective floodplain models. The largest difference in the published FIS versus predicted HEC-RAS based flood elevations occurred at Station 1806, with a difference of 0.44 foot.

A summary of HEC-RAS modeling results for the base flood flow is provided in in Table 2 for both existing and proposed site conditions. A complete listing of flood modeling results are provided in Appendix B. Compensatory storage has been included in the grading plan along the left overbank of the channel and within an off channel flood storage area in the south portion of the site. The compensatory storage included in the site grading plan is intended to preserve both flood storage and flood conveyance.

Modeling results show that the predicted base flood surface elevations for proposed site conditions closely match those predicted for existing site conditions. Based on the modeling results, the proposed grading and flood mitigation plan for the project site meets zero rise criteria.

Flood Storage Mitigation

The proposed site grading and flood mitigation plan includes delineation of the 100-year floodplain under mitigated conditions (bold dashed line in Figure 2). A tabulation of the flood elevations for 10-year, 50-year and 100-year return periods under proposed developed conditions is also provided in Figure 2.

Flood compensatory storage volumes are provided for all fill occurring in the floodplain. The volume of fill in the floodplain that requires mitigation was calculated using CAD using one surface to represent the existing topography and another surface, based on FEMA flood elevations, to represent the base flood water surface as published in the FIS. The existing pond that was excavated on the site as a borrow pit was assumed to be at its original grade prior to the excavation in establishing the topographic surface for existing conditions. A total flood storage volume of 11,358 cubic yards would be filled and a total compensatory storage volume of 13,112 cubic yards would be provided under the proposed grading plan (Encompass Engineering, April 2, 2015) leaving a net increase in flood storage of 1,754 cubic yards. Flood storage volumes at this time are preliminary and will be updated as the site grading plan and stream mitigation plan are finalized. Building pad elevations of proposed building on the site would be at least 2 feet above the published FEMA base flood elevations.

Flood Storage Mitigation Design

The flood mitigation has been designed with input from WDFW staff (Renfrow, 2014). The channel design includes grading a bench along the channel's left bank. The elevation of the bench has been designed to be approximately one-half to one foot above the OWH elevation identified in the field. The bank will be designed to provided additional conveyance capacity and flood storage while at the same time providing diversity in vegetation and channel structure. Woody debris will be installed along the bank to provide high flow refuge for fish. A significant volume of off-channel flood storage volume has been provided associated with a pond and surrounding grading. Offsite storage will be designed to drain back to the pond and then to the creek as floodwaters recede.

If you have questions regarding my assessment or conclusions, please call me at (425) 271-5734.

Sincerely,

Edward J. McCarthy

Edward J. McCarthy, Ph.D., P.E.

References

Adams, John. November 19, 2014. Personal communication with FEMA Engineering Library regarding information request for Wilson Creek flood study – email.

Encompass Engineering, April 2, 2015. *Surf City Grading and Compensatory Storage Mitigation Plan*. Issaquah, Wash.

Renfrow, Brent. December 12, 2014. Meeting at Washington Department of Fish and Wildlife Ellensburg Office – Topic: Stream and Floodplain Mitigations. Ellensburg, Wash.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. 2002. *HEC-RAS, River Analysis System User's Manual*, Version 3.1. Davis, California.

U.S. Army Corps of Engineers, 2008. HECRAS 4.0 Computer Software. Hydrologic Engineering Center, Davis, CA.

Table 1. Comparison of FIS base flood elevations to HEC-RAS model results (Existing Conditions) for Wilson Creek.

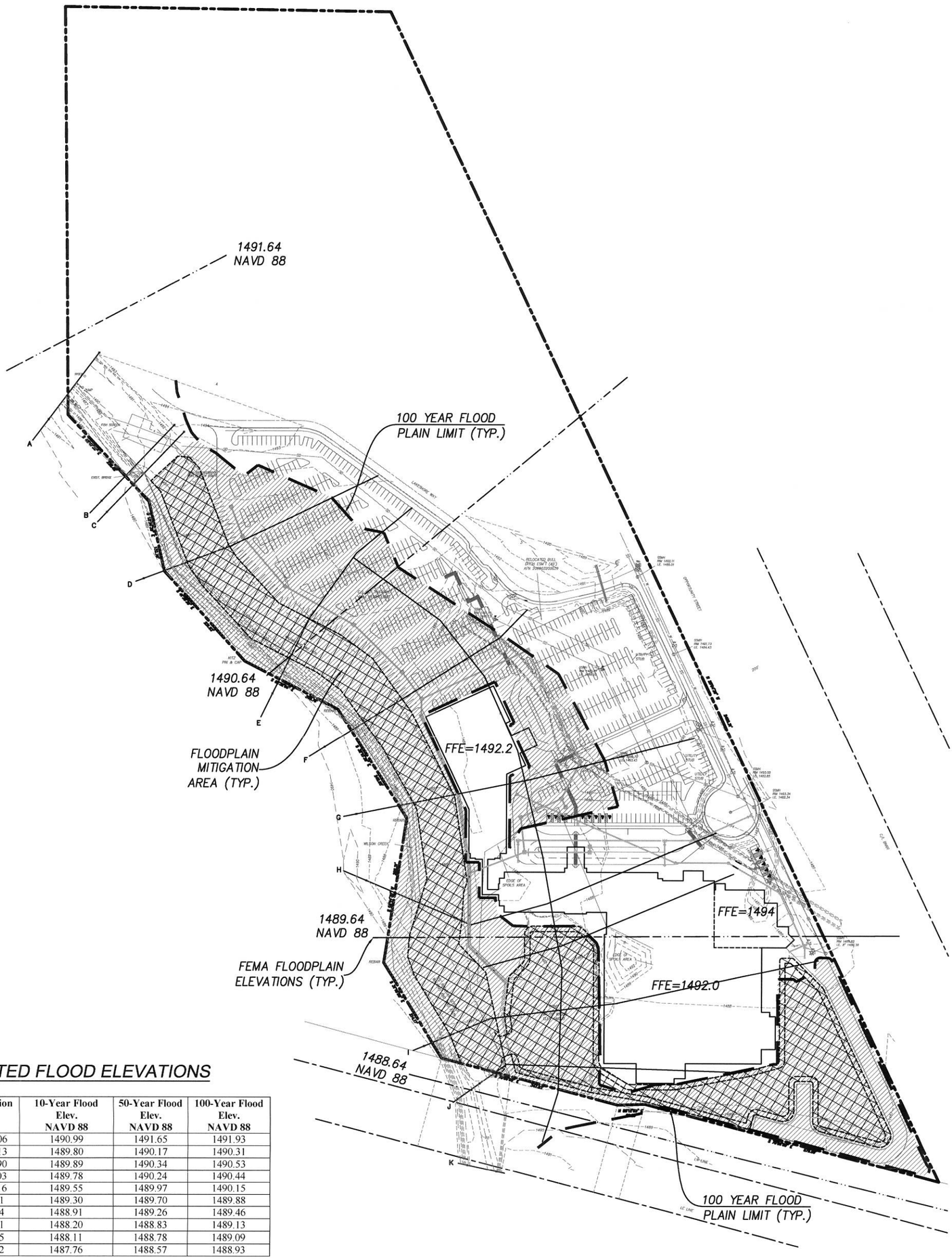
River Station	Cross Section	FEMA FIS Base Flood Elevation (Feet – NAVD 88)	HEC-RAS Base Flood Elevation – Existing Conditions (Feet – NAVD 88)	Difference (Feet – NAVD 88)
1806	A	1491.64	1492.08	0.44
1116	E	1490.64	1490.50	-0.14
475	H1	1489.64	1489.26	-0.38
0	K	1488.64	1488.70	0.06

Note: FEMA base flood elevations are based on FIRM.

Table 2. Comparison of HEC-RAS Existing Conditions model base flood elevations to predicted elevations for Proposed Developed Conditions for Wilson Creek.

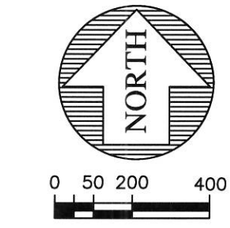
River Station	Cross Section	HEC-RAS Base Flood Elevation – Existing Conditions (Feet – NAVD 88)	HEC-RAS Base Flood Elevation – Proposed Developed Conditions (Feet – NAVD 88)	Difference (Feet – NAVD 88)
1806	A	1492.08	1491.93	-0.15
1116	E	1490.50	1490.15	-0.35
475	H1	1489.26	1489.09	-0.17
0	K	1488.70	1488.70	0.00

Appendix A. FEMA Published Information



PREDICTED FLOOD ELEVATIONS

Section	Station	10-Year Flood Elev. NAVD 88	50-Year Flood Elev. NAVD 88	100-Year Flood Elev. NAVD 88
A	1806	1490.99	1491.65	1491.93
B	1613	1489.80	1490.17	1490.31
C	1590	1489.89	1490.34	1490.53
D	1403	1489.78	1490.24	1490.44
E	1116	1489.55	1489.97	1490.15
F	931	1489.30	1489.70	1489.88
G	754	1488.91	1489.26	1489.46
H	561	1488.20	1488.83	1489.13
I	275	1488.11	1488.78	1489.09
J	162	1487.76	1488.57	1488.93



SCALE 1" = 200'

LEGEND

FLOOD STORAGE MITIGATION AREA

FLOODPLAIN HAZARD AREA

F HEC-RAS CROSS SECTION

FEMA BASE FLOOD ELEVATION (NGVD 88)

FLOOD STORAGE CALCULATIONS:

FLOOD STORAGE FILLED = 11,358 CY
FLOOD STORAGE MITIGATED = 13,112 CY

EXCESS FLOOD STORAGE = 1,754 CY

FIGURE 2 GRADING AND MITIGATION PLAN	PREPARED FOR CRI MANAGEMENT LLC	Encompass ENGINEERING & SURVEYING Western Washington Division 165 NE Juniper Street, Suite 201 • Issaquah, WA 98027 • Phone: (425) 392-6550 • Fax: (425) 392-6055 407 Swiftwater Blvd. • Cle Elum, WA 98922 • Phone: (509) 674-7433 • Fax: (509) 674-7418	REVISIONS	JOB NO. 14161 DATE 04/02/15 SCALE 1"=200'	FG-2 SHEET

Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Wilson Creek					
At Mouth[3]	396	3,100	4,250	4,750	5,900
Upstream of Confluence With Cherry Creek, Cross Section N	--[4]	2,050	2,750	3,000	3,700
Upstream of Confluence With Naneum Creek, Cross Section AB[3]	--[2]	1,550	2,170	2,360	2,950
At Cross Section BT[5]	--[2]	290	440	475	655
At Upstream Study Limit	--[2]	475	680	770	986
Right Channel Wilson Creek					
At Cross Section C[3]	--[2]	1,260	1,610	1,725	2,045
At Upstream Study Limit	--[2]	243	347	393	501
Reecer Creek					
At Downstream Detailed Study Limit, Cascade Way	40.0	280	400	450	560
At Cross Section E	--[2]	100	140	160	200
Currier Creek					
At Downstream Detailed Study Limit, Cascade Way[6]	40.0	280	400	450	560
At Dry Creek Connection Road	26.6	180	255	290	360
Whiskey Creek					
At 5th Street	--[2]	75	105	175[7]	275[7]
At Upstream Study Limit	10.3	75	105	118	147
Mercer Creek					
At Mouth	15.6	110	150	220[7]	310[7]
At Railroad Avenue	--[2]	110	150	170	210

Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Caribou Creek					
At Downstream Study Limit	36.7	294	417	471	595
Teanaway River					
At Mouth	207	5,300	6,700	7,350	8,700
At Cross Section EF	172	4,600	5,950	6,450	7,650
Upstream of Confluence With North Fork Teanaway River, At Cross Section EU	69.0	2,400	3,000	3,300	3,900
North Fork Teanaway River					
At Mouth	95.0	2,900	3,700	4,000	4,750
Middle Fork Teanaway River					
At Mouth	30.0	1,250	1,570	1,700	2,020
West Fork Teanaway River					
At Mouth	39.3	1,300	1,640	1,780	2,080
At Upstream Study Limit	19.2	790	1,000	1,080	1,260

[1] Discharges Reflect Regulated Conditions
[2] Distributary from Main Channel
[3] Includes Overflow from Yakima River, Reecer, and Currier Creeks
[4] Not Available
[5] Includes Overflow from Reecer and Currier Creeks
[6] Combined Values Reecer and Currier Creeks
[7] Includes Overflow from Reecer Creek

Appendix B. HEC-RAS Model Results

HEC-RAS Plan	Description
Existing	Project site under existing conditions. Simulates 100-year, 50-year, 10-year and estimated OWH flow rates for Wilson Creek.
Proposed4-7-15	Project site under proposed developed conditions with flood mitigations in place. Simulates 100-year, 50-year, 10-year and estimated OWH rates for Wilson Creek.

HEC-RAS River: Wilson Reach: R1

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	1806	500-Yr	Existing	710.00	1485.58	1492.57		1492.62	0.000901	2.37	477.36	200.71	0.18
R1	1806	500-Yr	Proposed4-7-15	710.00	1485.58	1492.49		1492.55	0.000998	2.47	458.30	200.48	0.19
R1	1806	100-Yr	Existing	561.00	1485.58	1492.08		1492.14	0.001004	2.35	380.50	199.23	0.18
R1	1806	100-Yr	Proposed4-7-15	561.00	1485.58	1491.93		1492.01	0.001237	2.56	347.32	198.78	0.20
R1	1806	50-Yr	Existing	497.00	1485.58	1491.85		1491.92	0.001063	2.34	335.22	198.63	0.19
R1	1806	50-Yr	Proposed4-7-15	497.00	1485.58	1491.65		1491.72	0.001227	2.45	295.07	184.68	0.20
R1	1806	10-Yr	Existing	349.00	1485.58	1491.18		1491.23	0.001074	2.13	231.13	167.15	0.19
R1	1806	10-Yr	Proposed4-7-15	349.00	1485.58	1490.99		1491.06	0.001371	2.33	207.31	162.35	0.21
R1	1806	OHW	Existing	60.00	1485.58	1488.67		1488.69	0.000852	1.17	51.48	27.21	0.15
R1	1806	OHW	Proposed4-7-15	60.00	1485.58	1488.67		1488.69	0.000854	1.17	51.45	27.20	0.15
R1	1613	500-Yr	Existing	710.00	1487.09	1491.23	1490.39	1492.09	0.016171	7.47	106.87	146.53	0.68
R1	1613	500-Yr	Proposed4-7-15	710.00	1487.09	1490.49	1490.40	1491.86	0.033295	9.42	75.69	33.47	0.96
R1	1613	100-Yr	Existing	561.00	1487.09	1490.98	1489.97	1491.61	0.012818	6.39	88.82	89.82	0.60
R1	1613	100-Yr	Proposed4-7-15	561.00	1487.09	1490.31	1489.96	1491.28	0.025203	7.91	71.17	30.50	0.83
R1	1613	50-Yr	Existing	497.00	1487.09	1490.85		1491.39	0.011283	5.87	85.31	70.02	0.56
R1	1613	50-Yr	Proposed4-7-15	497.00	1487.09	1490.17		1491.01	0.023266	7.37	67.59	26.18	0.79
R1	1613	10-Yr	Existing	349.00	1487.09	1490.39		1490.74	0.008976	4.79	73.08	31.76	0.49
R1	1613	10-Yr	Proposed4-7-15	349.00	1487.09	1489.80		1490.36	0.018430	6.00	58.21	25.16	0.69
R1	1613	OHW	Existing	60.00	1487.09	1487.81	1487.81	1488.14	0.053757	4.56	13.16	20.46	1.00
R1	1613	OHW	Proposed4-7-15	60.00	1487.09	1487.81	1487.81	1488.14	0.054217	4.57	13.13	20.46	1.01
R1	1590	500-Yr	Existing	710.00	1485.26	1491.57		1491.76	0.002850	3.80	248.80	153.93	0.31
R1	1590	500-Yr	Proposed4-7-15	710.00	1485.26	1490.96		1491.30	0.005589	4.89	179.07	132.57	0.42
R1	1590	100-Yr	Existing	561.00	1485.26	1491.19		1491.36	0.002715	3.51	203.37	143.64	0.29
R1	1590	100-Yr	Proposed4-7-15	561.00	1485.26	1490.53		1490.85	0.005494	4.57	137.30	104.09	0.41
R1	1590	50-Yr	Existing	497.00	1485.26	1491.01		1491.17	0.002582	3.35	184.57	132.62	0.29
R1	1590	50-Yr	Proposed4-7-15	497.00	1485.26	1490.34		1490.63	0.005161	4.31	122.16	66.85	0.40
R1	1590	10-Yr	Existing	349.00	1485.26	1490.45		1490.58	0.002299	2.92	130.17	91.81	0.27
R1	1590	10-Yr	Proposed4-7-15	349.00	1485.26	1489.89		1490.08	0.003884	3.47	101.98	38.60	0.34
R1	1590	OHW	Existing	60.00	1485.26	1487.84		1487.88	0.001766	1.45	41.24	26.36	0.20
R1	1590	OHW	Proposed4-7-15	60.00	1485.26	1487.76		1487.79	0.002114	1.54	38.93	26.14	0.22
R1	1403	500-Yr	Existing	710.00	1483.57	1491.35		1491.43	0.000962	2.75	421.27	193.03	0.19
R1	1403	500-Yr	Proposed4-7-15	710.00	1483.57	1490.85		1490.90	0.000773	2.34	464.94	413.71	0.17
R1	1403	100-Yr	Existing	561.00	1483.57	1490.98		1491.06	0.000893	2.55	349.76	193.03	0.18
R1	1403	100-Yr	Proposed4-7-15	561.00	1483.57	1490.44		1490.48	0.000688	2.10	398.79	337.33	0.16
R1	1403	50-Yr	Existing	497.00	1483.57	1490.81		1490.89	0.000844	2.43	317.55	193.03	0.17

HEC-RAS River: Wilson Reach: R1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	1403	50-Yr	Proposed4-7-15	497.00	1483.57	1490.24		1490.28	0.000660	2.01	370.49	323.88	0.15
R1	1403	10-Yr	Existing	349.00	1483.57	1490.29		1490.35	0.000659	2.02	240.96	138.74	0.15
R1	1403	10-Yr	Proposed4-7-15	349.00	1483.57	1489.78		1489.82	0.000543	1.72	304.84	191.32	0.14
R1	1403	OHW	Existing	60.00	1483.57	1487.78		1487.79	0.000198	0.75	80.82	29.12	0.08
R1	1403	OHW	Proposed4-7-15	60.00	1483.57	1487.68		1487.69	0.000219	0.77	78.13	29.71	0.08
R1	1116	500-Yr	Existing	710.00	1484.93	1490.85		1491.01	0.002644	3.85	333.21	275.23	0.30
R1	1116	500-Yr	Proposed4-7-15	710.00	1484.93	1490.54		1490.62	0.001511	2.79	367.59	365.26	0.23
R1	1116	100-Yr	Existing	561.00	1484.93	1490.50		1490.66	0.002556	3.60	252.11	194.27	0.30
R1	1116	100-Yr	Proposed4-7-15	561.00	1484.93	1490.15		1490.22	0.001510	2.63	311.80	346.38	0.22
R1	1116	50-Yr	Existing	497.00	1484.93	1490.37		1490.51	0.002314	3.36	229.20	169.03	0.28
R1	1116	50-Yr	Proposed4-7-15	497.00	1484.93	1489.97		1490.03	0.001419	2.47	287.46	259.14	0.22
R1	1116	10-Yr	Existing	349.00	1484.93	1489.94		1490.05	0.001915	2.86	168.48	127.96	0.25
R1	1116	10-Yr	Proposed4-7-15	349.00	1484.93	1489.55		1489.60	0.001222	2.14	235.46	138.33	0.20
R1	1116	OHW	Existing	60.00	1484.93	1487.65		1487.68	0.000964	1.28	47.00	23.34	0.16
R1	1116	OHW	Proposed4-7-15	60.00	1484.93	1487.54		1487.57	0.001140	1.35	44.38	22.99	0.17
R1	931	500-Yr	Existing	710.00	1483.75	1490.56		1490.63	0.001307	2.86	514.02	509.48	0.21
R1	931	500-Yr	Proposed4-7-15	710.00	1483.75	1490.29		1490.35	0.001118	2.56	495.07	434.14	0.19
R1	931	100-Yr	Existing	561.00	1483.75	1490.14		1490.24	0.001704	3.10	365.56	468.70	0.24
R1	931	100-Yr	Proposed4-7-15	561.00	1483.75	1489.88		1489.94	0.001246	2.56	387.82	360.93	0.20
R1	931	50-Yr	Existing	497.00	1483.75	1490.03		1490.13	0.001671	3.03	326.47	459.51	0.23
R1	931	50-Yr	Proposed4-7-15	497.00	1483.75	1489.70		1489.76	0.001280	2.54	347.70	325.81	0.20
R1	931	10-Yr	Existing	349.00	1483.75	1489.64		1489.73	0.001423	2.65	218.45	353.76	0.21
R1	931	10-Yr	Proposed4-7-15	349.00	1483.75	1489.30		1489.36	0.001240	2.36	260.73	251.36	0.20
R1	931	OHW	Existing	60.00	1483.75	1487.54		1487.56	0.000426	1.01	59.28	22.55	0.11
R1	931	OHW	Proposed4-7-15	60.00	1483.75	1487.41		1487.43	0.000488	1.06	56.47	21.07	0.11
R1	754	500-Yr	Existing	710.00	1484.86	1490.01		1490.21	0.004633	4.66	398.16	641.89	0.39
R1	754	500-Yr	Proposed4-7-15	710.00	1484.86	1489.96		1490.05	0.002315	3.27	357.09	355.87	0.27
R1	754	100-Yr	Existing	561.00	1484.86	1489.60		1489.76	0.004199	4.16	268.65	544.43	0.36
R1	754	100-Yr	Proposed4-7-15	561.00	1484.86	1489.46		1489.58	0.003118	3.51	258.34	311.71	0.31
R1	754	50-Yr	Existing	497.00	1484.86	1489.44		1489.63	0.004750	4.31	220.82	499.38	0.38
R1	754	50-Yr	Proposed4-7-15	497.00	1484.86	1489.26		1489.38	0.003370	3.52	223.29	274.02	0.32
R1	754	10-Yr	Existing	349.00	1484.86	1489.11		1489.30	0.004519	3.96	144.62	347.05	0.37
R1	754	10-Yr	Proposed4-7-15	349.00	1484.86	1488.91		1489.01	0.003050	3.13	172.81	124.27	0.30
R1	754	OHW	Existing	60.00	1484.86	1487.37		1487.42	0.002018	1.73	34.78	19.54	0.22
R1	754	OHW	Proposed4-7-15	60.00	1484.86	1487.20		1487.26	0.002688	1.90	31.65	18.39	0.25

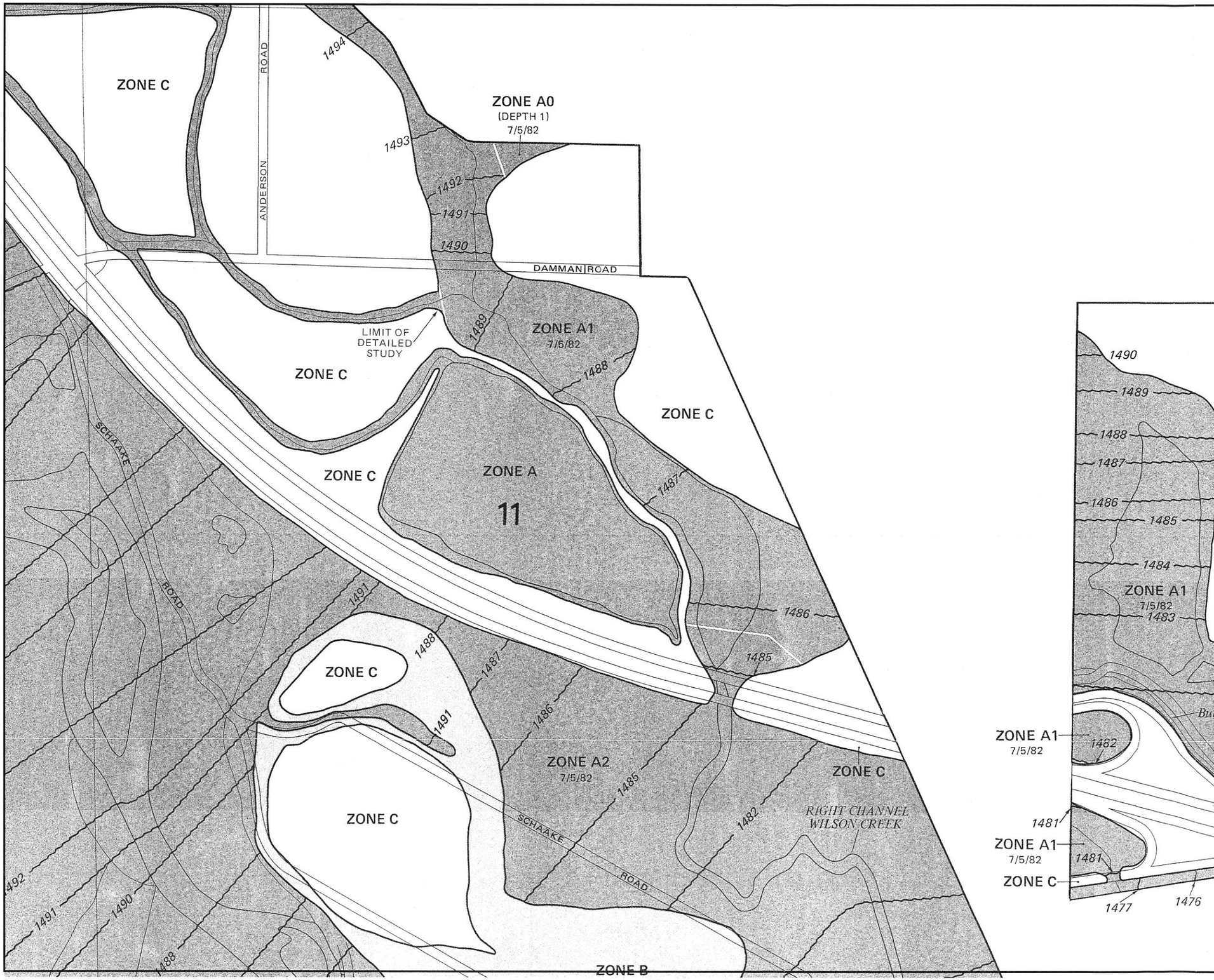
HEC-RAS River: Wilson Reach: R1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	561	500-Yr	Existing	710.00	1484.79	1489.84		1489.87	0.000671	1.86	717.59	717.64	0.15
R1	561	500-Yr	Proposed4-7-15	710.00	1484.79	1489.74		1489.77	0.000793	1.99	612.01	281.74	0.16
R1	561	100-Yr	Existing	561.00	1484.79	1489.32		1489.35	0.001020	2.12	525.49	700.77	0.18
R1	561	100-Yr	Proposed4-7-15	561.00	1484.79	1489.13		1489.16	0.001241	2.26	444.91	264.45	0.20
R1	561	50-Yr	Existing	497.00	1484.79	1489.12		1489.15	0.001204	2.22	453.43	695.61	0.20
R1	561	50-Yr	Proposed4-7-15	497.00	1484.79	1488.83		1488.88	0.001687	2.50	367.67	259.80	0.23
R1	561	10-Yr	Existing	349.00	1484.79	1488.73		1488.78	0.001472	2.30	319.73	443.58	0.21
R1	561	10-Yr	Proposed4-7-15	349.00	1484.79	1488.20		1488.31	0.003851	3.34	206.14	253.28	0.34
R1	561	OHW	Existing	60.00	1484.79	1487.00		1487.04	0.001888	1.68	37.63	30.73	0.22
R1	561	OHW	Proposed4-7-15	60.00	1484.79	1486.40		1486.49	0.006335	2.48	24.16	18.15	0.38
R1	475.*	500-Yr	Existing	710.00	1484.63	1489.80	1488.06	1489.82	0.000579	1.47	787.88	717.35	0.12
R1	475.*	500-Yr	Proposed4-7-15	710.00	1484.63	1489.71		1489.72	0.000332	1.10	934.07	450.30	0.09
R1	475.*	100-Yr	Existing	561.00	1484.63	1489.26	1488.00	1489.27	0.000874	1.66	588.53	708.09	0.14
R1	475.*	100-Yr	Proposed4-7-15	561.00	1484.63	1489.09		1489.10	0.000488	1.21	706.69	431.97	0.11
R1	475.*	50-Yr	Existing	497.00	1484.63	1489.04	1487.94	1489.06	0.001039	1.75	511.05	705.07	0.16
R1	475.*	50-Yr	Proposed4-7-15	497.00	1484.63	1488.78		1488.80	0.000623	1.30	599.21	402.82	0.12
R1	475.*	10-Yr	Existing	349.00	1484.63	1488.64	1487.74	1488.67	0.001202	1.75	375.25	412.78	0.16
R1	475.*	10-Yr	Proposed4-7-15	349.00	1484.63	1488.11		1488.13	0.001181	1.57	384.48	367.61	0.16
R1	475.*	OHW	Existing	60.00	1484.63	1486.79	1485.58	1486.84	0.002934	1.72	35.06	21.97	0.23
R1	475.*	OHW	Proposed4-7-15	60.00	1484.63	1486.27		1486.28	0.001224	0.92	68.55	79.55	0.14
R1	275	500-Yr	Existing	710.00	1484.26	1489.62		1489.66	0.001531	2.36	483.47	747.44	0.19
R1	275	500-Yr	Proposed4-7-15	710.00	1484.26	1489.61		1489.64	0.000839	1.85	593.53	574.39	0.15
R1	275	100-Yr	Existing	561.00	1484.26	1488.93		1489.01	0.003058	3.00	320.43	704.57	0.27
R1	275	100-Yr	Proposed4-7-15	561.00	1484.26	1488.93		1488.97	0.001383	2.15	432.12	572.78	0.18
R1	275	50-Yr	Existing	497.00	1484.26	1488.54		1488.69	0.005529	3.77	228.24	471.73	0.35
R1	275	50-Yr	Proposed4-7-15	497.00	1484.26	1488.57		1488.62	0.002088	2.49	345.33	571.91	0.22
R1	275	10-Yr	Existing	349.00	1484.26	1487.63	1486.67	1488.07	0.015889	5.36	69.50	307.69	0.57
R1	275	10-Yr	Proposed4-7-15	349.00	1484.26	1487.76		1487.82	0.002981	2.56	189.37	558.34	0.25
R1	275	OHW	Existing	60.00	1484.26	1485.63		1485.75	0.013038	2.75	21.84	19.45	0.46
R1	275	OHW	Proposed4-7-15	60.00	1484.26	1485.63		1485.75	0.012970	2.74	21.88	213.64	0.46
R1	162	500-Yr	Existing	710.00	1482.94	1489.56		1489.58	0.000393	1.24	685.99	557.46	0.10
R1	162	500-Yr	Proposed4-7-15	710.00	1482.94	1489.56		1489.58	0.000385	1.23	692.21	296.79	0.10
R1	162	100-Yr	Existing	561.00	1482.94	1488.87		1488.89	0.000495	1.25	544.22	555.58	0.11
R1	162	100-Yr	Proposed4-7-15	561.00	1482.94	1488.87		1488.89	0.000483	1.23	550.37	292.42	0.11

HEC-RAS River: Wilson Reach: R1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	162	50-Yr	Existing	497.00	1482.94	1488.48		1488.50	0.000612	1.29	466.33	554.67	0.12
R1	162	50-Yr	Proposed4-7-15	497.00	1482.94	1488.48		1488.50	0.000594	1.28	472.45	290.13	0.12
R1	162	10-Yr	Existing	349.00	1482.94	1487.62		1487.65	0.001046	1.40	293.45	552.63	0.15
R1	162	10-Yr	Proposed4-7-15	349.00	1482.94	1487.62		1487.64	0.000966	1.35	303.12	273.53	0.15
R1	162	OHW	Existing	60.00	1482.94	1485.26		1485.28	0.001814	1.10	54.38	193.22	0.17
R1	162	OHW	Proposed4-7-15	60.00	1482.94	1485.27		1485.28	0.001810	1.10	54.58	196.86	0.17
R1	0	500-Yr	Existing	710.00	1483.14	1489.40	1485.82	1489.47	0.001075	2.22	334.74	74.32	0.17
R1	0	500-Yr	Proposed4-7-15	710.00	1483.14	1489.40	1485.82	1489.47	0.001075	2.22	334.74	74.32	0.17
R1	0	100-Yr	Existing	561.00	1483.14	1488.70	1485.56	1488.76	0.001105	2.04	284.10	70.38	0.17
R1	0	100-Yr	Proposed4-7-15	561.00	1483.14	1488.70	1485.56	1488.76	0.001105	2.04	284.10	70.38	0.17
R1	0	50-Yr	Existing	497.00	1483.14	1488.30	1485.42	1488.36	0.001194	2.00	256.25	68.91	0.17
R1	0	50-Yr	Proposed4-7-15	497.00	1483.14	1488.30	1485.42	1488.36	0.001194	2.00	256.25	68.91	0.17
R1	0	10-Yr	Existing	349.00	1483.14	1487.40	1485.10	1487.45	0.001371	1.81	195.72	65.61	0.18
R1	0	10-Yr	Proposed4-7-15	349.00	1483.14	1487.40	1485.10	1487.45	0.001371	1.81	195.72	65.61	0.18
R1	0	OHW	Existing	60.00	1483.14	1484.79	1484.16	1484.82	0.005006	1.44	41.70	48.67	0.27
R1	0	OHW	Proposed4-7-15	60.00	1483.14	1484.79	1484.15	1484.82	0.005006	1.44	41.70	48.67	0.27

Figure 1. Aerial photo of January 2009 flood. The project reach of Wilson Creek is in the upper right corner of the photo (Source: City of Ellensburg Public Works).



APPROXIMATE SCALE

500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KITTITAS COUNTY, WASHINGTON
(UNINCORPORATED AREAS)

PANEL 552 OF 700
(SEE MAP INDEX FOR PANELS NOT PRINTED)

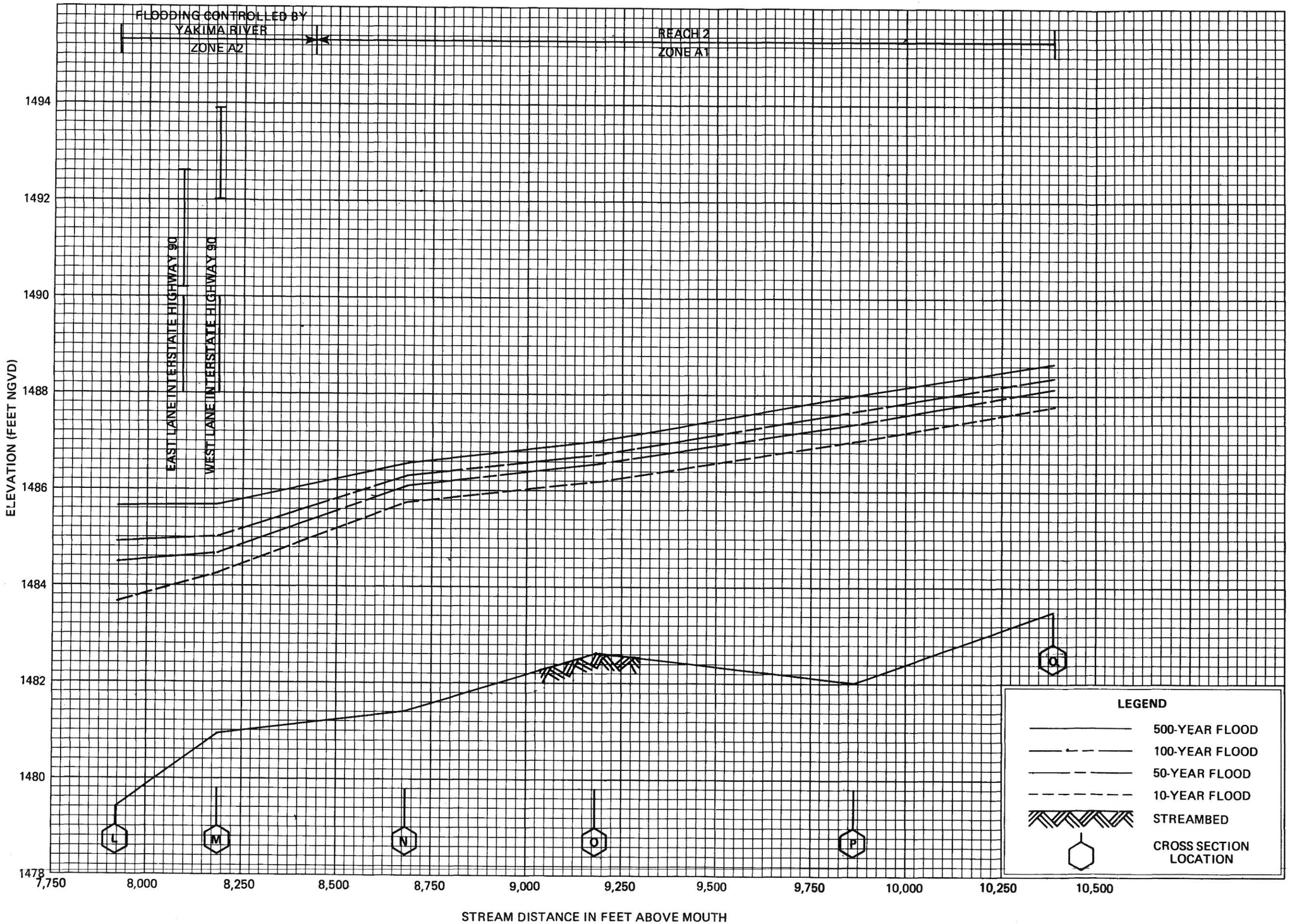
Vertical Datum: NGVD 29

COMMUNITY-PANEL NUMBER
530095 0552 C

MAP REVISED:
JULY 5, 1982

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

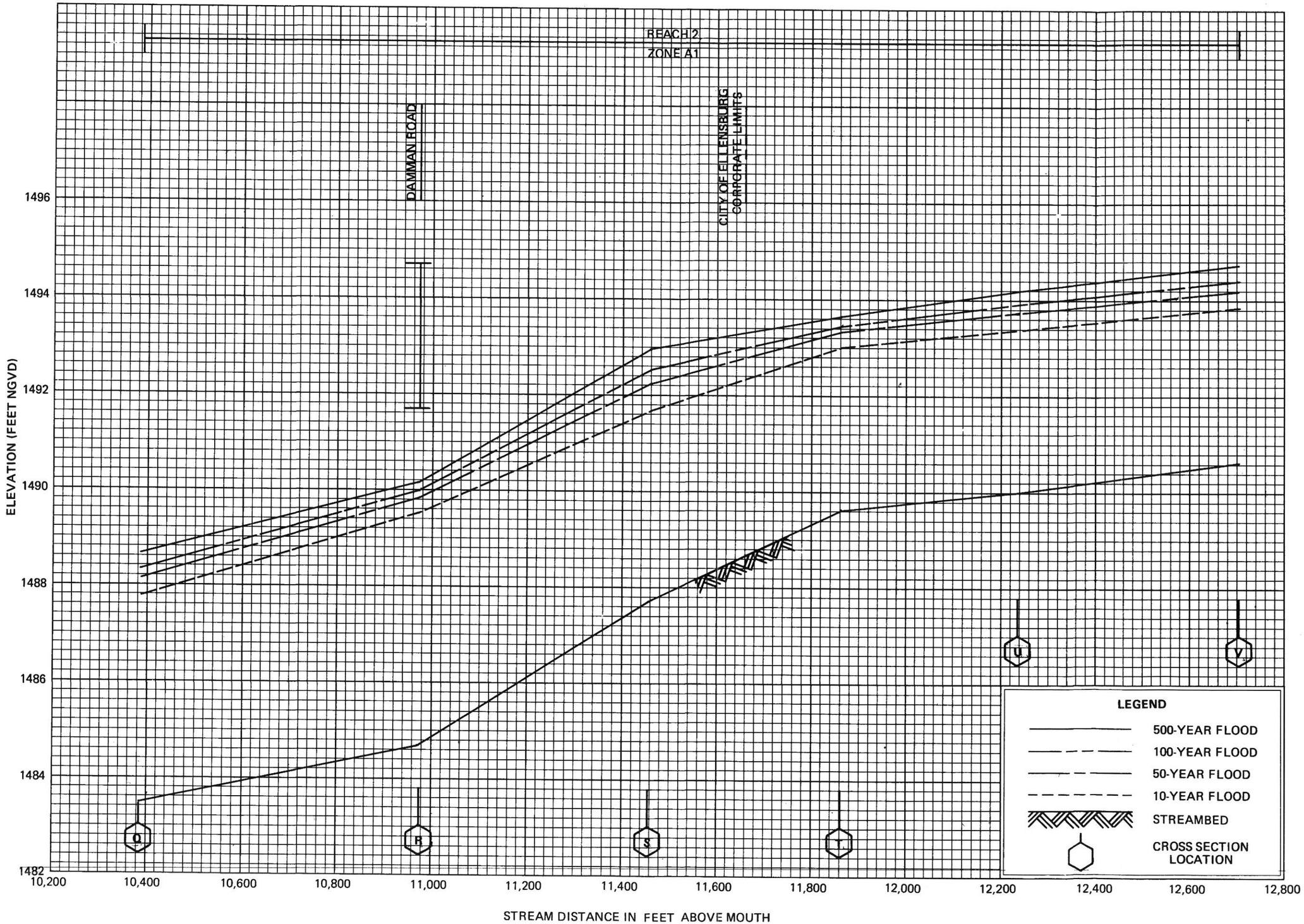


FLOOD PROFILES

RIGHT CHANNEL WILSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KITTITAS COUNTY, WA



FLOOD PROFILES

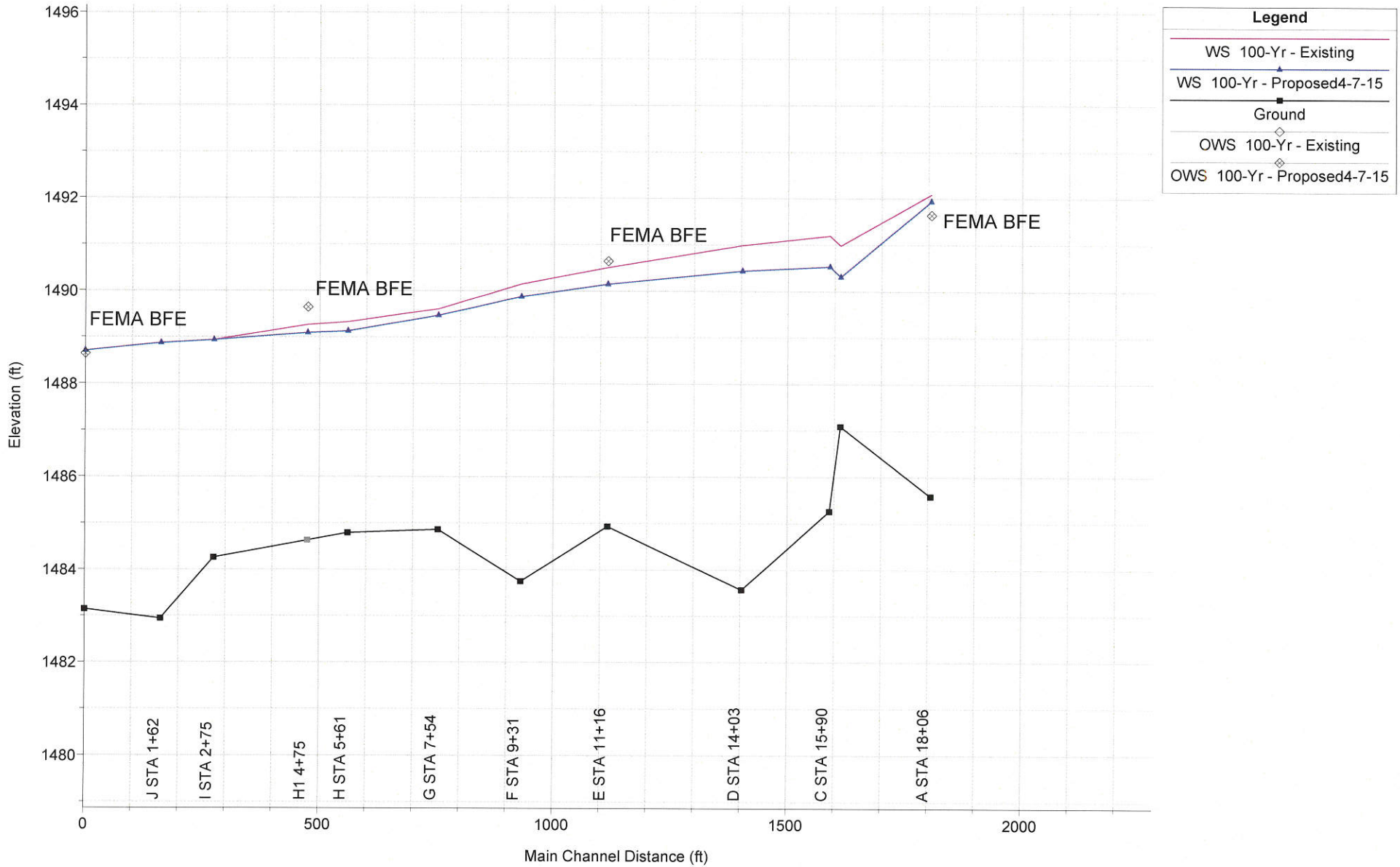
RIGHT CHANNEL WILSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KITTITAS COUNTY, WA

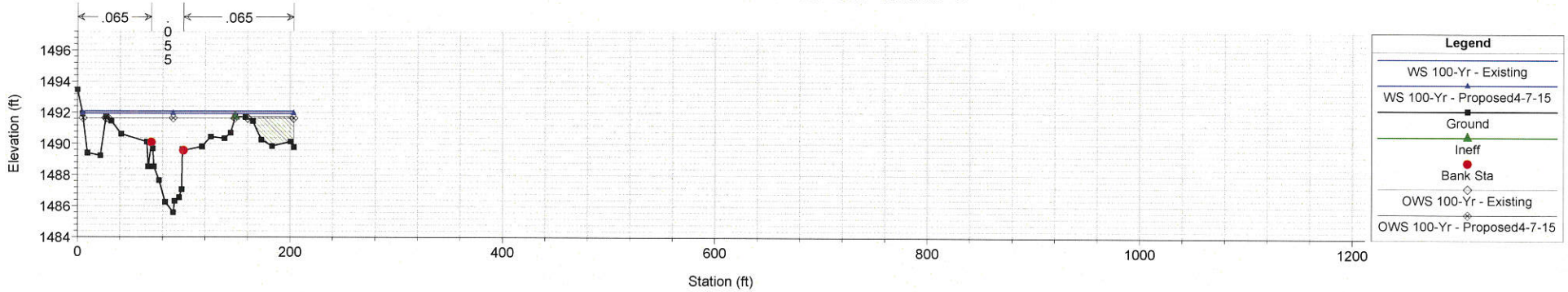
112P

Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

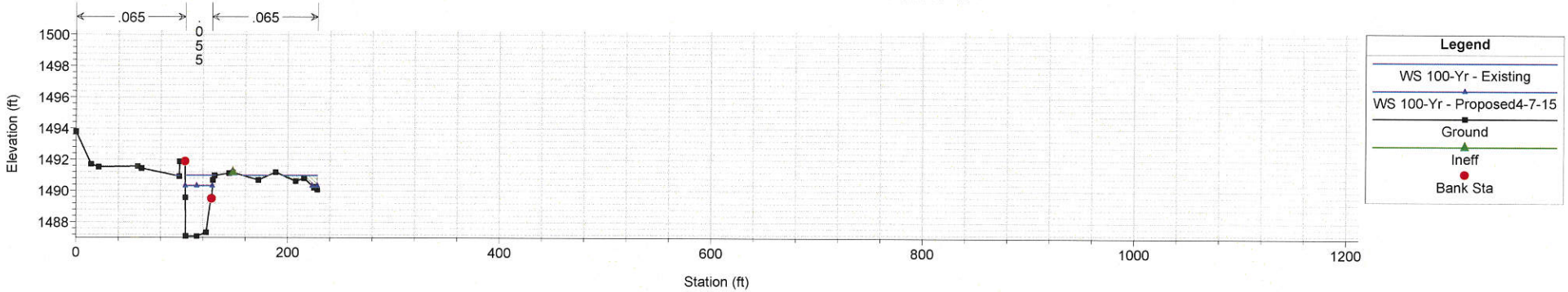


1 in Horiz. = 300 ft 1 in Vert. = 3 ft

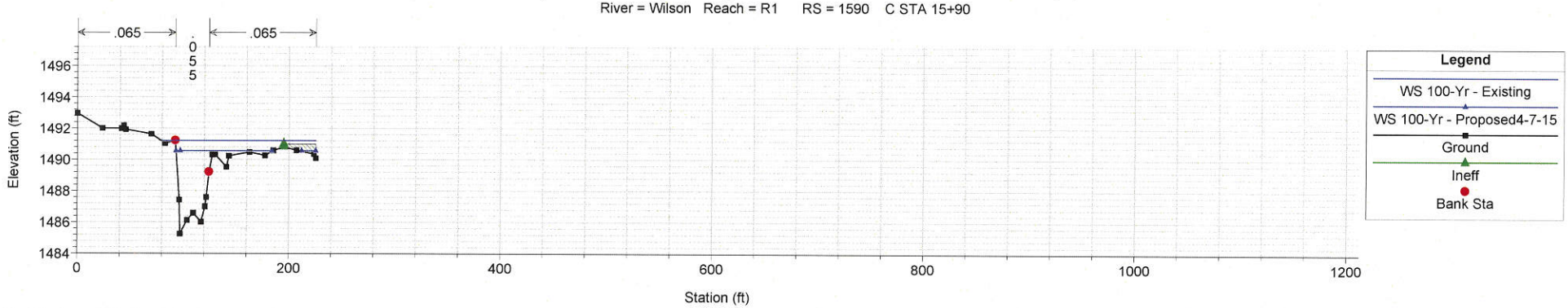
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 1806 A STA 18+06



Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 1613 B STA 16+13



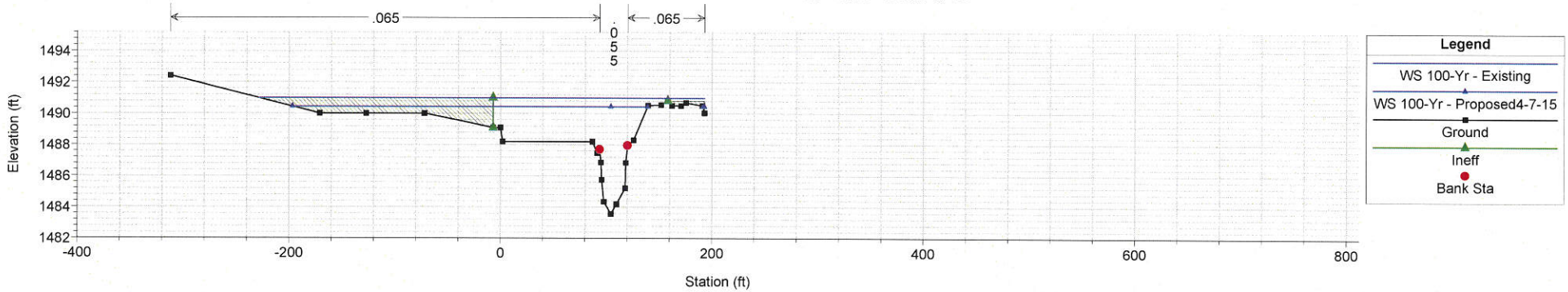
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 1590 C STA 15+90



1 in Horiz. = 150 ft 1 in Vert. = 10 ft

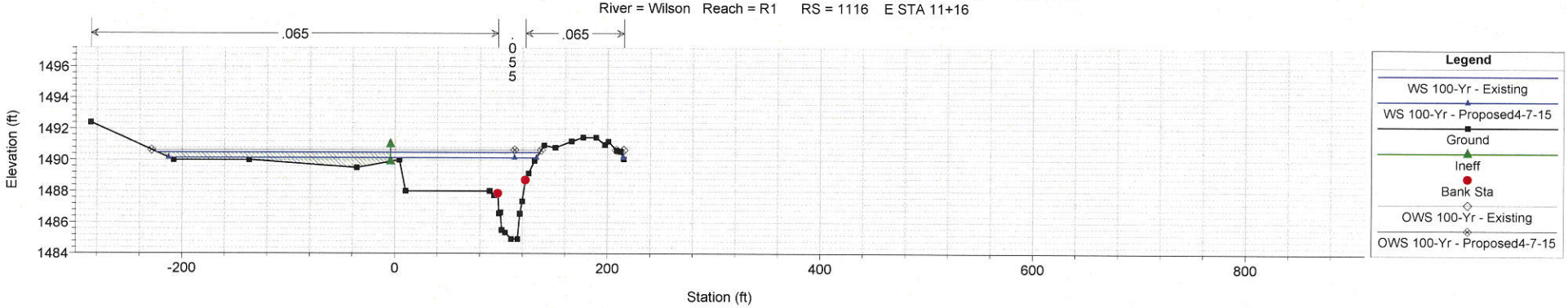
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

River = Wilson Reach = R1 RS = 1403 D STA 14+03



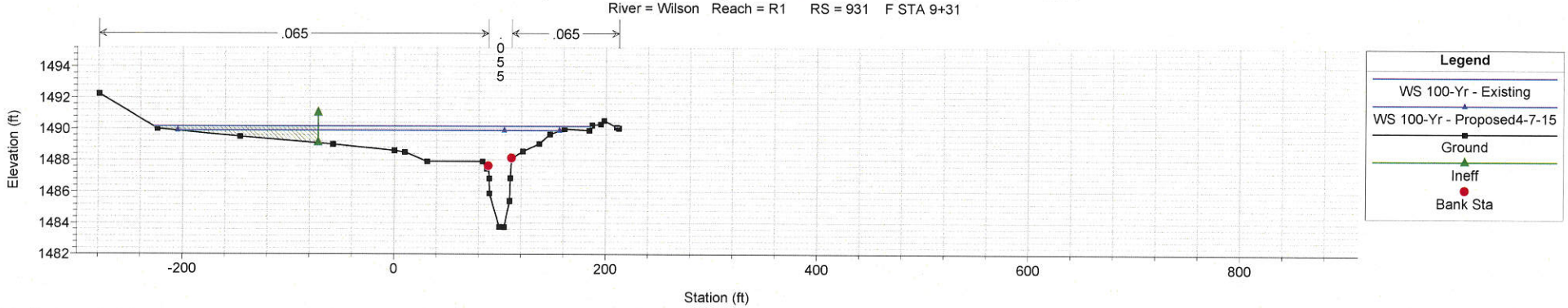
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

River = Wilson Reach = R1 RS = 1116 E STA 11+16



Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

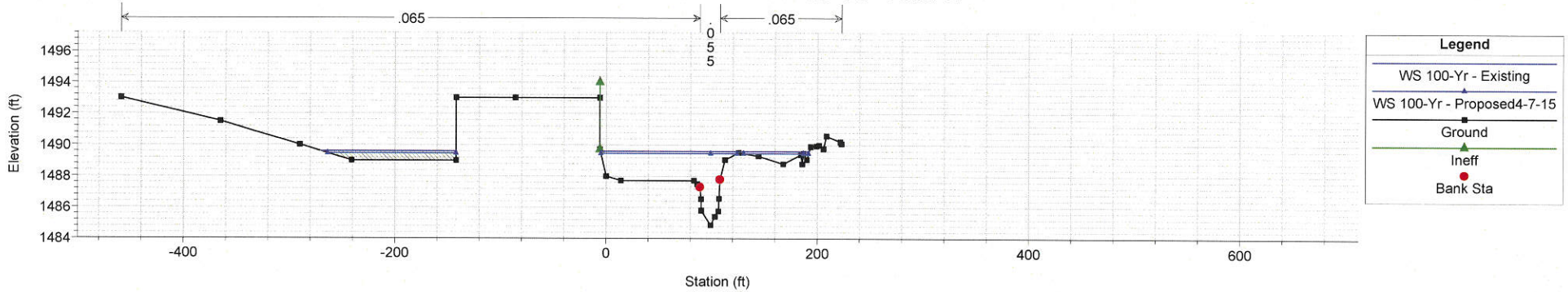
River = Wilson Reach = R1 RS = 931 F STA 9+31



1 in Horiz. = 150 ft 1 in Vert. = 10 ft

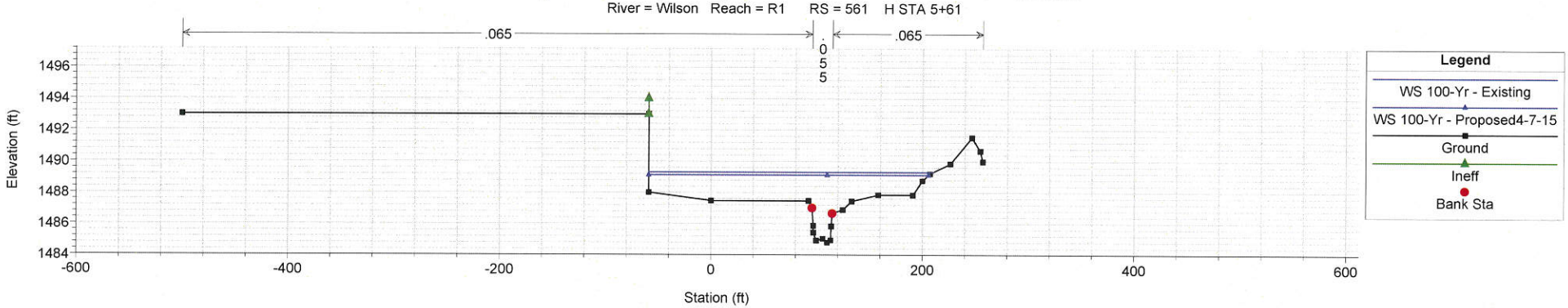
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

River = Wilson Reach = R1 RS = 754 G STA 7+54



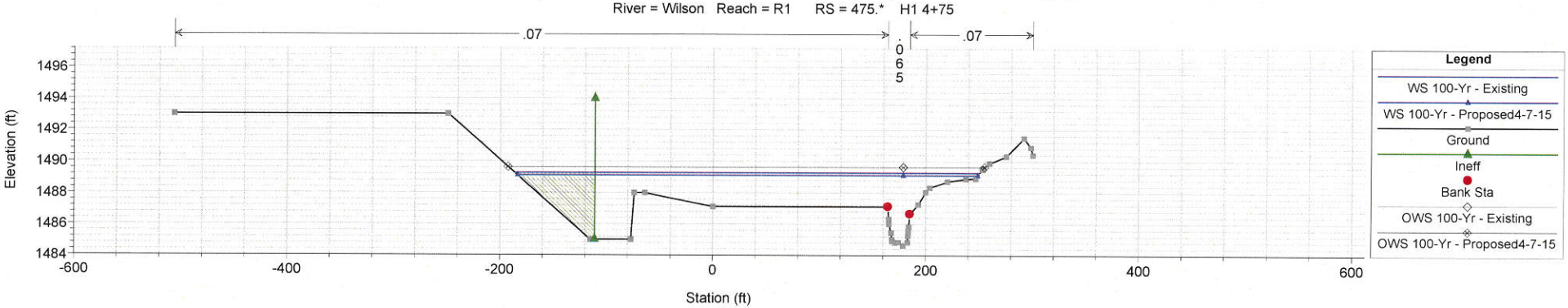
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

River = Wilson Reach = R1 RS = 561 H STA 5+61



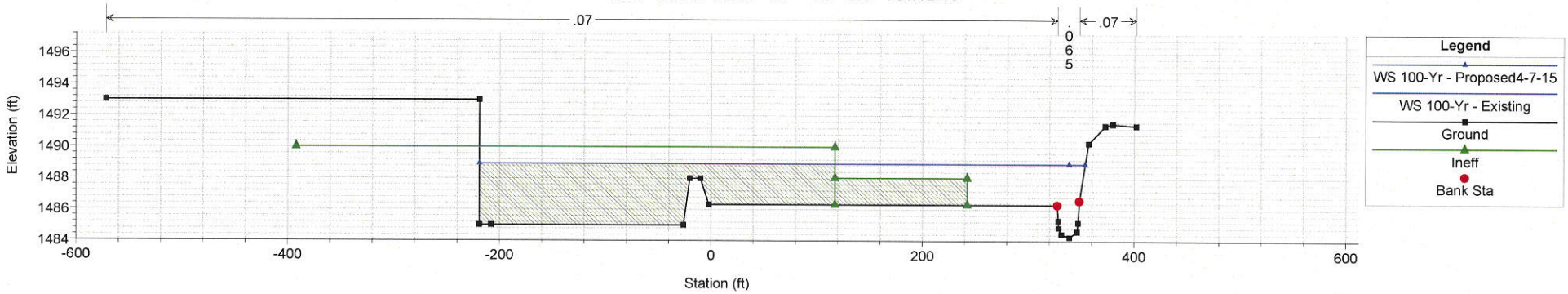
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015

River = Wilson Reach = R1 RS = 475.* H1 4+75

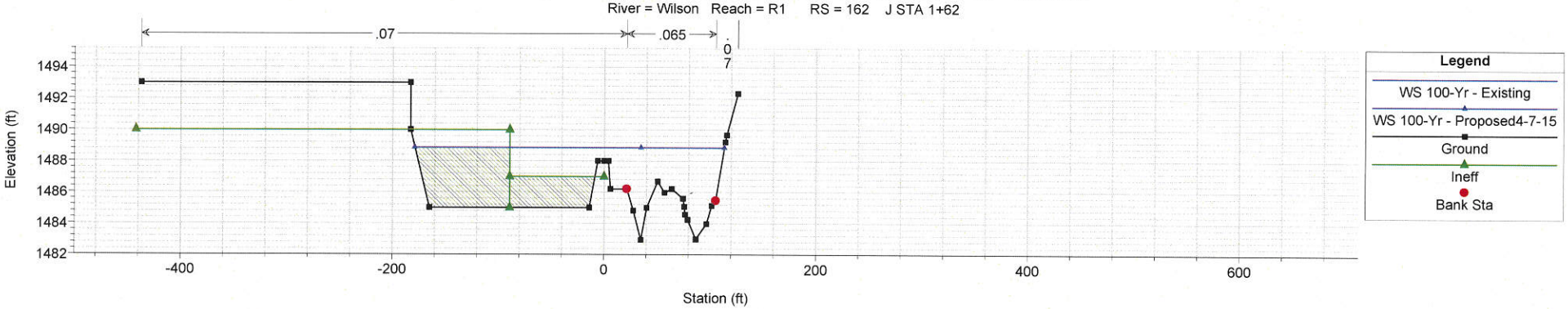


1 in Horiz. = 150 ft 1 in Vert. = 10 ft

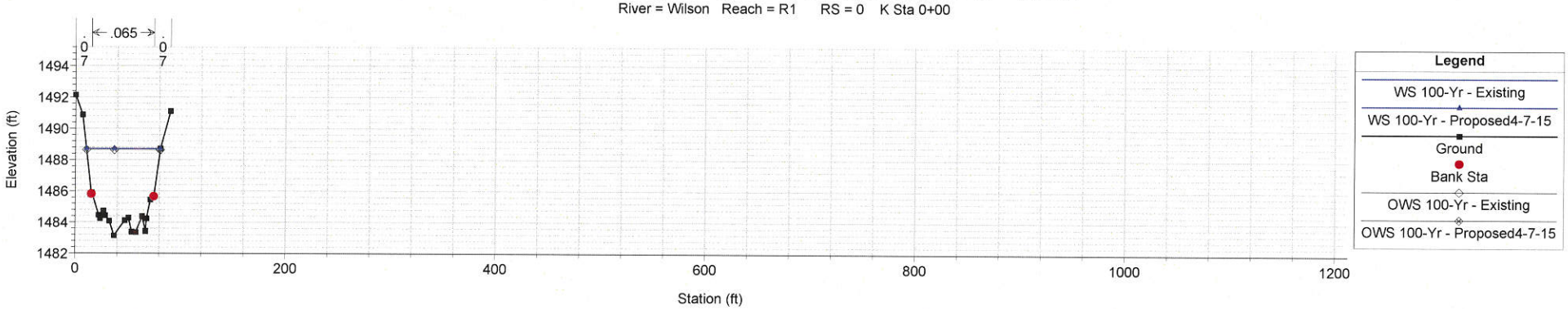
Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 275 I STA 2+75



Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 162 J STA 1+62



Surf City Plan: 1) Existing 4/7/2015 2) Proposed4-7-15 4/7/2015
River = Wilson Reach = R1 RS = 0 K Sta 0+00



1 in Horiz. = 150 ft 1 in Vert. = 10 ft